

# DETERMINATION OF MULTI-ITEM INVENTORY MODEL WITH LIMITATIONS OF WAREHOUSE CAPACITY AND UNIT DISCOUNT IN LEADING GARMENT INDUSTRY IN INDONESIA

RAFLY ISFANUR YASSA<sup>1</sup> & ZULFA FITRI IKATRINASARI<sup>2</sup>

<sup>1</sup>Master Student of Industrial Engineering Program, Mercu Buana University, Jakarta, Indonesia

<sup>2</sup>Senior Lecturer, Department of Industrial Engineering, Faculty of Engineering,  
Mercu Buana University, Jakarta, Indonesia

## ABSTRACT

*Inventory is important so that the company's production process runs smoothly and efficiently. To maintain the supply of raw materials, it is necessary to have an appropriate inventory control system so that inventory problems can be minimized. The raw material used is a type of multi-item to produce intimates of apparel is bra. The actual usage data of raw materials during January - December 2017 experienced a stock out of Nylon Tricot, N / S Elastane, FS Fiberfill, Mesh SM135 and Spacer. Management of raw material inventories has constraints that is the limit of warehouse capacity and discount units. This study aims to determine the number of economical orders and the frequency of bookings for a year with constraints on warehouse capacity and discount units. The method used is EOQ probabilistic multi-item Lagrange Multiplier (LM) and dynamic programming method approaching the Wagner-Within algorithm. From the two methods then compared to find the most optimal solution in determining the number of orders that are economical. The Wagner-within method produces a Total Annual Cost (TAC) of Rp. 137,453,491, while  $Q^*$  was Rp. 187,339,290 and  $Q^*$  lagrange multiplier of Rp. 135,982,935. The optimal results seen from the TAC of all the minimum raw materials are obtained by the  $Q^*$  lagrange multiplier method. With this method  $Q^*$  lagrange multiplier is recommended for planning multi-item raw material control in the company.*

**KEYWORDS:** Inventory Control, Multi-Item EOQ, Lagrange Multiplier Wagner Within, Warehouse Capacity, Discount Units & Total Annual Cost (TAC)

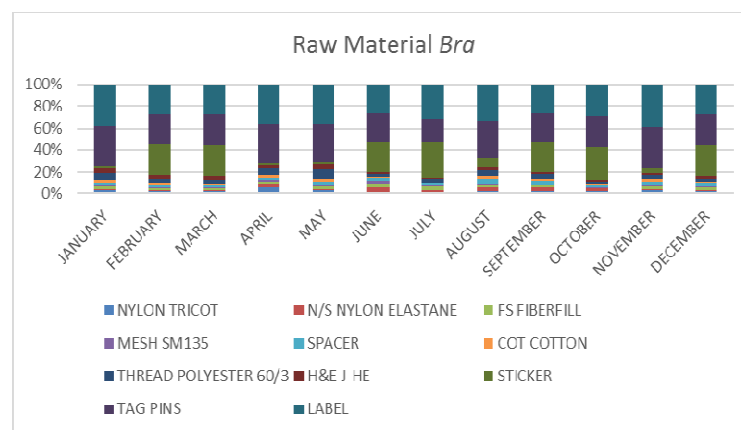
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## INTRODUCTION

Heizer and Render (2017) studied that Inventory is the most expensive asset of the company which represents 50% of the total capital invested. Related to that, the problem of the supply of raw materials is very important to support the effectiveness and efficiency of production lines in a company. Yen (2012) in its development, the garment industry experienced a rapid increase in terms of the needs and competition between companies. Most of the world's major producers of apparel in 2012 were located on the Asian continent. Gotexshow (2015) states that the share of Asian continent apparel production in 2012 was more than 65%. Nine of the world's 15 major apparel producers are on the Asian continent. As for Indonesia, as one of the world's leading producers, it has a production share of 1.1% from the world apparel industry production. The important thing to do is by fulfilling the raw materials on time, in number and type. Sutanto(2014) studied the more optimal fulfilment of raw material requirements, the company will have high competitiveness in the competition for the garment

industry development. In the world of garment-related industries, the cost of input that is very dominating is the cost of the raw material for apparel. The cost structure of apparel production in Indonesia is still dominated by raw material costs that is 57.7% (Sutanto, 2014). This is very important to observe regarding the handling of raw materials, because if the raw material is not controlled by inventory, the lost costs will be very large in this industry. So from that the importance of inventory control in the world of garment became an interesting topic to be used as research material.

One underwear company in Indonesia today often has problems related to Bra raw material supplies, where the problem that often arises is the determination of the number of orders that are economical, the number of orders (frequency) in one period is still not optimal, and when is the right time to order return raw materials so that production continues to run as expected. The following data on raw material for multi-item bra making for the period January - December 2017 can be seen in Fig. 1.



**Figure 1: Raw Material of Bra (2017)**

From Figure 1 above, there is a difference in the use of raw materials that experience a stock out are Nylon Tricot, N / S Nylon Elastane, FS Fiberfill, Mesh SM135 and Spacer. Difference data can be seen in table 1.

**Table 1: Difference of Raw Material of Bra Usage in 2017**

MONTH	NYLON TRICOT	N/S NYLON ELASTANE	FS FIBERFILL	MESH SM135	SPACER
JANUARY	-10.038	-2.159	-9.734	-2.67	-2.255
FEBRUARY	-7.408	-2.168	-6.827	-1.013	-1.406
MARCH	-8.02	-2.63	-8.58	-13.696	-9.484
APRIL	-76.844	-16.496	-17.012	-2.698	-19.019
MAY	-20.262	-2.162	-20.262	-1.432	-1.965
JUNE	-10.198	-39.714	-64.428	-11.201	-6.225
JULY	-8.344	-8.205	-75.423	-2.734	-7.69
AUGUST	-4.967	-16.61	-4.967	-1.723	-19.7
SEPTEMBER	-22.887	-57.944	-22.887	-1.647	-46.031
OCTOBER	-31.122	-17.667	-44.912	-19.591	-8.922
NOVEMBER	-61.243	-27.15	-61.243	-76.597	-25.838
DECEMBER	-47.908	-6	-33.116	-4.787	-5.224

Tersine (1994) states that in real conditions, the company has not used the right raw material control method, this study aims to use several inventory control methods by comparing the methods of the Economic Order Quantity (EOQ) Multi-Item and Dynamic Program (DP). Where for EOQ is used to find an economical number of orders, order time and exact ordering frequency, with various characteristics of raw materials, the mathematical approach to find the optimal EOQ

solution with a large number of items is by the Lagrange method. According to Wagner and Whitin(1958) in addition to the use of the EOQ method, determining the economical number of orders can use the dynamic program method, the dynamic program method provides a more optimal total cost. Richard (1994) studiedThe Wagner-within Method (WW) aims to obtain an optimum ordering strategy by minimizing ordering costs and saving costs. In the case of the number of orders and the time of ordering are non-permanent. This method stipulates that do not place an order as long as there is stock or the order is made after the inventory is zero at the end of the planning period. Utama(2016) states that Dynamic programs can also be used by considering capacity constraints, with dynamic programming methods with limits on warehouse capacity to provide a minimum total cost. According to Wijaya and Widyadana (2013) Dynamic programs by considering discount units are more optimal when compared to EOQ. The use of WW method can minimize costs incurred in terms of inventory costs [Madinahet al (2015); Mbotaet al (2015)]. Development of the WW algorithm method is carried out to determine the optimal solution of inventory control with limits.

Determination of the number of orders with the constraints of warehouse capacity and discount units requires comprehensive observation in order to achieve the optimal solution. To determine the size of the order with these constraints using the development model of the dynamic algorithm programme Wagner Whitin (WW) and EOQ multi-item with the Lagrange Multiplier method approach. With the hope that the two models can find the most optimal solution for determining the number of orders.

## METHODOLOGY

In planning raw material inventories in the garment industry in West Java where raw materials are multi-item, there are costs that must be incurred in the procurement of raw materials and limits on warehouse capacity and discount units. Information about analysing raw material inventory planning so that it is efficient and effective to minimize the shortage of raw materials produced will be described as follows:

### Multi-item EOQ with Lagrange Multiplier

This case will consider the problem of cost budgeting by requiring many points of solution, but the total investment in inventory does not exceed B unit of money represented by the formulation:

$$\sum_{i=1}^n C_i Q_i \leq B \quad (1)$$

With :

$C_i$  = unit price of product items  $i$  in rupiah

$Q_i$  = optimal order quantity of product items  $i$  in the unit

$B$  = the amount of investment in inventory in rupiah

As a first step, it is necessary to look for the optimal order quantity by ignoring any constraints or constraints, so to get the  $Q_i$  value \* formulation is used:

$$Q_i^* = \sqrt{\frac{2A_i D_i}{a C_i}} \quad (2)$$

From the calculation through equation 2, check the condition by substituting the  $Q_i$  value \* in equation 1. If the value of  $Q_i$  \* is not satisfactory, then the Lagrange method will be used. This problem can be solved by developing the

Lagrange Expression (LE) or Lagrange equation :

$$LE(Q_i, \lambda) = \sum_{i=1}^n \left( \frac{A_i D_i}{Q_i} + \frac{a}{2} C_i Q_i \right) + \lambda \left( \sum_{i=1}^n C_i Q_i - B \right) \quad (3)$$

Notation  $\lambda$  is a Lagrange multiplier. By taking derivatives or derivatives from equation 3 which is conditioned on the value of  $Q_i$ ,  $\lambda$ , and resolving the equation with the right segment there is zero, then the formulation is obtained:

$$Q_{Li}^* = \sqrt{\frac{2 A_i D_i}{C_i (a + 2\lambda^*)}} \quad (4)$$

$Q^* Li$  value is the optimal order quantity obtained from the use of the Lagrange method. Notation  $\lambda^*$  can be obtained by formulation:

$$\lambda^* = \frac{1}{2} \left( \frac{1}{B} \sum \sqrt{2 A_i D_i C_i} \right)^2 - \frac{a}{2} \quad (5)$$

then substitute it in equation 4 and will give the equation:

$$Q_{Li}^* = \frac{B}{\sum_{i=1}^n C_i Q_i^*} Q_i^* = \frac{B}{E} Q_i^* \quad (6)$$

For  $Q^* i$  is searched by equations 2 and E searched by equation:

$$E = \sum_{i=1}^n C_i Q_i^* \quad (7)$$

annotation:

$C_i$  = item price per unit in rupiah

$A_i$  = the cost of procuring or ordering per item in rupiah

$D_i$  = request for forecasting results in the unit

$B$  = maximum allowable investment in the company in rupiah

$E$  = total inventory investment without constraints in rupiah

$Q^* i$  = optimal order quantity without constraints in units

$Q^* Li$  = optimal order quantity with Lagrange in the unit

$Q_i$  = order quantity resulting from forecasting in the unit

$\lambda^*$  = Lagrange multiplier

$a$  = inventory storage costs in percentages

### Dynamic Program with Wagner-Within (WW) Algorithm

The steps in the WW Algorithm that are developed taking into account the constraints of the discount unit and the capacity of this warehouse are as follows:

- Calculate the matrix of the total variable costs (message costs and save costs) for all alternative orders across the planning horizon consisting of  $N$  periods. Define  $Z_{ce}$  as the total variable cost (from Period  $c$  to Period  $e$ ) if the order is conducted in Period  $c$  to fulfill the request for Period  $c$  to Period  $e$ . The  $Z_{ce}$  formula is as follows:

$$Z_{ce} = C + I * P_j \sum_{i=c}^e (Q_{ce} - Q_{di}) + Q_{ce} * P_j \text{ untuk } 1 \leq c \leq e \leq N$$

Dengan

$$Q_{ce} = \sum_{k=c}^e D_k \quad (8)$$

- Check the value of  $Q_{ce}$  provided that the  $Q_{ce}$  value does not exceed warehouse capacity & discount units.
- Eliminate the total variable cost ( $Z_{ce}$ ) that exceeds the warehouse capacity and discount unit.
- Define  $f_e$  as the minimum possible cost in Periods 1 to Period  $e$ , assuming the inventory level at the end of Period  $e$  is zero. The algorithm starts with  $f_0 = 0$  and starts counting sequentially  $f_1, f_2, \dots, f_N$ . The  $f_N$  value is the cost of the optimal order.

$$F_e = \text{Min} \{Z_{ce} + f_{c-1}\} \text{ untuk } c = 1, 2, \dots, e. \quad (9)$$

Interpret  $f_N$  into lot size as follows:

$$f_N = Z_{wN} + f_{w-1} \text{ Last-order is made in Period } w \text{ to fulfill requests from Period } w \text{ to Period } N. \quad (10)$$

$$f_{w-1} = Z_{vw-1} + f_{v-1} \text{ Orders prior to the last order must be made in period } v \text{ to fulfill requests from period } v \text{ to period } w-1. \quad (11)$$

$$f_{u-1} = Z_{1u-1} + f_0 \text{ The first order must be made in period } 1 \text{ to fulfill requests from period } 1 \text{ to period } 1. \quad (12)$$

From the calculation of the Wagner-Whitin algorithm dynamic programme, then compared with the Economic Order Quantity (EOQ) procedure. After calculating the EOQ, it is found that the value of the total inventory cost is greater than the total cost of the initial inventory, then the EOQ calculation is performed with Lagrange Multiplier. The procedure for obtaining the optimum quantity of raw material orders is if there are discount units and warehouse capacities in order to aim to minimize the total cost of inventory with the following steps:

- Calculate  $Q^*$  for each raw material with equation 2
- Compare  $Q^*$  with the limit of the amount of material ordered where there is a change in the price level. If  $Q^*$  is at the limit of the number of materials ordered and smaller or equal to capacity means  $Q^*$  is valid. Valid  $Q^*$  data are used for calculations looking for the Total Annual Cost (TAC).
- Compare the value of  $Q^*$  with the initial minimum total inventory cost, if it is greater than the total cost of the initial inventory, an EOQ calculation is performed using the Lagrange Multiplier. To find Lagrange Multiplier with equation 3-6.
- Calculate the Total Annual Cost (TAC) for each valid  $Q^*$  and  $Q^*$  Lagrange Multiplier. With the formula:

$$TAC = OC + PC + IC \quad (13)$$

Where :

TAC: Total annual inventory cost

OC: Total booking fee

PC: Total cost of purchase

IC: Total storage costs

- Compare the results of the TAC calculation for  $Q^*$  valid with the dynamic program method, find the minimum.

To find a solution from the above method, the required data is as follows:

**Table 2: Ordering Cost**

No	Raw Material	Ordering Cost (Rp)
1	Nylon Tricot	4,512,000
2	N/S Nylon Elastane	4,512,000
3	FS Fiberfill	4,512,000
4	Mesh SM 135	4,512,000
5	Spacer	4,512,000

**Table 3: Unit Discount**

Order Quantity (YD)	Unit Discount (Rp)				
	Nylon Tricot	N/S Nylon Elastane	FS Fiberfill	Mesh SM 135	Spacer
0-100	14,550	22,529	19,799	25,650	15,245
101-200	14,050	21,529	19,129	24,550	14,695
201-300	13,550	20,529	18,459	23,450	14,145
301-400	13,050	19,529	17,789	22,350	13,595
401-500	12,550	18,529	17,119	21,250	13,045
501>	12,050	17,529	16,449	20,150	12,495

**Table 4: Capacity of Raw Material Warehouse**

No	Raw Material	Amount	Capacity/Rack	Total
1	Nylon Tricot	5	200	1000
2	N/S Nylon Elastane	5	200	1000
3	FS Fiberfill	4	200	800
4	Mesh SM 135	2	200	400
5	Spacer	5	200	1000

The holding cost 1% per month per price per units and for the year accumulated at 12%.

## RESULTS AND DISCUSSIONS

### Calculation of EOQ Multi-item with Lagrange Multiplier

Calculate the value of  $Q^*$  based on equation 2 with data on the governance of each raw material using forecasting data. Compare  $Q^*$  with the limit on the amount of material ordered. If  $Q^*$  is at the interval of the number of materials ordered and smaller means showing a valid  $Q^*$ , this valid  $Q^*$  will be the data for calculating the value of the investment. The following recapitulation of the calculation of  $Q^*$  can be seen in table 5.

**Table 5:  $Q^*$  Validation Recapitulation with Limitations**

Quantity	Nylon Tricot	N/S Nylon Elastane	FS Fiberfill	Mesh SM 135	Spacer	Remark
0-100	2699.811759	2369.47706	2094.125441	1422.240694	3142.61854	Not Valid
101-200	2747.431157	2423.88235	2130.483559	1453.754384	3200.8888	Not Valid
201-300	2797.662577	2482.21598	2168.803652	1487.460227	3262.52544	Not Valid
301-400	2850.753888	2544.97466	2209.268769	1523.624761	3327.86558	Not Valid
401-500	2906.987192	2612.7477	2252.086798	1562.562216	3397.29563	Not Valid
500>	2966.68515	2686.24051	2297.494976	1604.646083	3471.26086	Valid

Then compare the value of the initial total investment with the total investment value  $Q^*$ . If the result is greater  $Q^*$ , the settlement uses Lagrange Multiplier. To find total investment using equation 7 while looking for  $Q^* Li$  with equation 3-6. The following is a recapitulation of the calculation of the initial inventory investment value and  $Q^*$ .

**Table 6: Calculation of the Value of the Initial Investment (Rp)**

Raw Material	Initial Inventory	Total Investment
Nylon Tricot	1410.3	16994139.1
N/S Nylon Elastane	1682.01	29483988.35
FS Fiberfill	1154.6	18991982.5
Mesh SM 135	689.947	13902432.05
Spacer	2002.13	25016651.84
<b>Total</b>		<b>104389193.8</b>

**Table 7: Calculation of the Value of the  $Q^*$  Investment (Rp.)**

Raw Material	$Q^*$	Total Investment
Nylon Tricot	2966.69	35748556.06
N/S Nylon Elastane	2686.24	47087109.95
FS Fiberfill	2297.49	37791494.87
Mesh SM 135	1604.65	32333618.58
Spacer	3471.26	43373404.5
<b>Total</b>		<b>196334184</b>

The total investment value  $Q^*$  shows greater than the initial inventory investment value. With that, Lagrange Multiplier calculations need to be done. The following is a recapitulation of the calculation of investment value for  $Q^* Li$ .

**Table 8: Calculation of the Value of the  $Q^*Li$  Investment (Rp.)**

Raw Material	$Q^*Li$	Total Investment
Nylon Tricot	1577.361	19007199.22
N/S Nylon Elastane	1428.251	25035810.62
FS Fiberfill	1221.558	20093412.18
Mesh SM 135	853.1765	17191506.38
Spacer	1845.639	23061265.43
<b>Total</b>		<b>104389193.8</b>

From the table above, the investment value for  $Q^* Li$  is equal to the value of the initial inventory investment, this proves that the calculation of  $Q^* Li$  gives satisfactory results.

#### **Calculation of Dynamics Program Wagner-Within**

To find solutions to solutions using the WW method you can use equations 8-12. The following is the recapitulation of the minimum costs for investment from each raw material. In table 9-13, the detailed calculation of WW inventory costs can be seen in table 14.



Table 9: Recapitulation of Minimum Cost Nylon Tricot in Rupiah

Fulfillment	Demand											
	e=1	e=2	e=3	e=4	e=5	e=6	e=7	e=8	e=9	e=10	e=11	e=12
	70.689	70.689	68.862	73.649	130.236	123.174	124.714	129.319	122.845	120.669	155.3	220.156
c = 1	5540525	6508293	7388992	8416874	9828532	11175177	12768149	14435523	16034228			
c = 2		10948150	11894559	12846909	14494362	15931844	17275552	18927344	20511246	22081632		
c = 3			12370489	13369207	15085607	16377793	17727262	19363471	20932570	22488416		
c = 4				16554413	18026928	19296798	20844686	22465312	24019608			
c = 5					14310004	15900779	17451182	18949556	20249182	21775946	23759593	
c = 6						16179340	17820675	19413622	20549570	22061794	24026727	
c = 7							17762924	19458849	20954863	22048892	23995112	26780635
c = 8								18690757	20275003	21770717	23606150	26113113
c = 9									20520646	22116078	24066356	26406574
c = 10										24527503	26202187	28682787
c = 11											32301433	34741052
c = 12												32124912
Min	5540525	6508293	7388992	8416874	9828532	11175177	12768149	14435523	16034228	21770717	23606150	26113113

Table 10: Recapitulation of Minimum Cost N/S Elastane in Rupiah

Fulfillment	Demand											
	e=1	e=2	e=3	e=4	e=5	e=6	e=7	e=8	e=9	e=10	e=11	e=12
	29.537	26.496	44.267	202.331	75.658	77.174	188.903	214.65	195.772	237.855	186.229	203.14
c = 1	5177439	5780337	6797574	10563084.7	12099710.8	13212630.1	16253019.38	20279001.22				
c = 2		10286367	11293632	15387946.4	16632214	17763858.3	20804931.01	24793286.85				
c = 3			11289628	15396283.6	16654737.9	18207082.9	20840251.4	24790981.24	28428569.9			
c = 4				15463226.9	17031941.8	18290469.9	20986162.9	24899266.74	28502538.5	6797573.809		
c = 5					16779583.8	18382019.6	21837680.53	25020588.78	28589543.7	32967371.97		
c = 6						18350363.8	22112785.39	25633648.17	28681377.2	33017511.86		
c = 7							21791522.79	25241836.14	28336457.8	32630898.88		
c = 8								25386219.23	28406003.2	32246371	35608711.4	
c = 9									29005776.6	32869748.06	35763438.8	39431105.1
c = 10										37731383.07	40740816.6	43946928.2
c = 11											15318897.9	18953232.2
c = 12												24001159
Min	5177439	5780337	6797574	10563084.7	12099710.8	13212630.1	16253019.38	20279001.22	28336457.8	6797573.809	15318897.9	18953232.2

Table 11: Recapitulation of Minimum Cost FS Fiberfill Rupiah

Fulfillment	Demand											
	e=1	e=2	e=3	e=4	e=5	e=6	e=7	e=8	e=9	e=10	e=11	e=12
	63.761	63.761	62.893	64.88	72.139	73.612	105.232	130.107	125.798	123.451	118.701	150.263
c = 1	5774404	6963565	8190707	9295407.48	10456397.7	11555681.5	13114826.2	15404765.3	17639556.7			
c = 2		11548808	12721199	13987110.5	15229054.2	16411515.7	18072361.1	20036173.8	22250272.6			
c = 3			12720784	13932145.8	15339691.7	16603917.3	18364626.2	20092827.3	22286233.7	24459024.4		
c = 4				13987266.1	15337542.9	16631236.8	18416775.5	20517956.2	22384798.4	24537282.7		
c = 5					15235687.5	16609559.6	18492740.3	20706586	22338909.8	24471087.6	26540751.1	
c = 6						16425841.7	18409634.4	20529336.2	22538032.6	24353645	26403783.44	29023760.09
c = 7							18080664.5	20435820.6	22559848.8	24492088	26192988.5	28788248.39
c = 8								20115643	22373797.6	24441489.7	26277827.75	28509789.71
c = 9									22323155.3	24540440.4	26526420.01	28574357.95
c = 10										24513050.9	26643351.52	29206803.46
c = 11											30897687.47	33314550.65
c = 12												33579369.43
Min	5774404	6963565	8190707	9295407.48	10456397.7	11555681.5	13114826.2	15404765.3	17639556.7	24353645	26192988.5	28509789.71

Table 12: Recapitulation of Minimum Cost SM Mesh 135 in Rupiah

Fulfillment	Demand											
	e=1	e=2	e=3	e=4	e=5	e=6	e=7	e=8	e=9	e=10	e=11	e=12
	36.319	36.319	35.763	38.503	42.133	41.815	69.94	72.798	70.663	68.56	77.328	99.806
c = 1	5443582	6384481	7199720	8173327	9249066.36	10066404.8	11804903.3	13203733.3				
c = 2		10887165	11813659	12698129	13763525	14831145.6	16334786.2	17760205.9				
c = 3			11813801	12729163	13784215.8	14841570.8	16370501.7	18162970.5	19496188.8			
c = 4				12699322	13790841	14748767.4	16517305.2	18077381.3	19437062.8			
c = 5					13766038.1	14849318.4	16507883.1	18094934.2	19818263.4	21092601.2		
c = 6						14833621.1	16521821.9	18344756.6	19846136.2	21154304.4		
c = 7							16372365.8	18100494.6	19632870.3	21288834.2	22771471.3	
c = 8								18184172	19856218.7	21337520.9	23205262.7	25202032.1
c = 9									19528239.2	21150489.4	22846198.4	24903120.9
c = 10										25707626.8	27549597.2	29775529.5
c = 11											27588064.4	29977743.2
c = 12												29843495.2
Min	5443582	6384481	7199720	8173327	9249066.36	10066404.8	11804903.3	13203733.3	19437062.8	21092601.2	22771471.3	24903120.9



**Table 13: Recapitulation of Minimum Cost Spacer in Rupiah**

Fulfillment	Demand											
	e=1	e=2	e=3	e=4	e=5	e=6	e=7	e=8	e=9	e=10	e=11	e=12
	81.072	81.072	75.697	78.026	87.133	92.244	168.82	197.405	207.158	228.484	284.348	420.674
c = 1	5747943	6906620	7909143	8869639	9875461.66	11138950.8	13095517.2	15734753				
c = 2		11495885	12574787	13613899	14703597.3	15775280.5	17757620.4	20372190.4	23141820.3			
c = 3			12572620	13689045	14861214.4	16019034.9	17840587.8	20430492	23174237.6			
c = 4				13610650	14860959	16100529.5	18082723	20409259.4	23127120.5			
c = 5					14709981.1	16031138.8	18173819.5	20326646.8	23018623.6	26016276.5		
c = 6						15793721.4	18104091.5	20441715.3	22852549.8	25821653.7		
c = 7							18131760.7	20656616.9	22891805.9	25832360.7		
c = 8								20508383.7	22912065.3	25600422	29259938.1	
c = 9									23177002.9	25959508.6	29342635.7	
c = 10										30596456	33807914.9	39169363
c = 11											34134524.5	38974235.1
c = 12												39259630.5
Min	5747943	6906620	7909143	8869639	9875461.66	11138950.8	13095517.2	15734753	22852549.8	25600422	29259938.1	38974235.1

**Table 14: Calculation of the Value of the WW Investment (Rp.)**

Raw Material	Total Investment
Nylon Tricot	26113112.98
N/S Nylon Elastane	18953232.22
FS Fiberfill	28509789.71
Mesh SM 135	24903120.94
Spacer	38974235.13
<b>Total</b>	<b>137453491</b>

After calculate the investment value of the WW, Q \* and Q \* Li methods, the calculation of the Total Annual Cost (TAC) is carried out with equation 13 and the calculation of ordering frequency.

**Table 15: Recapitulation of Calculations Total Annual Cost (TAC) (Rp.)**

Raw Material	Q*	Q*Li	Wagner-Within
Nylon Tricot	8697668.001	23520945	26113112.98
N/S Nylon Elastane	51601213.43	34061914	18953232.22
FS Fiberfill	42305468.75	24607386	28509789.71
Mesh SM 135	36848036.58	21705924	24903120.94
Spacer	47886903.9	32086765	38974235.13
<b>Total</b>	<b>187339290.7</b>	<b>135982935</b>	<b>137453491</b>

**Table 16: Recapitulation of Ordering Frequency**

Raw Material	Q*	Q*Lm	Wagner-Within
Nylon Tricot	1	1	2
N/S Nylon Elastane	1	2	3
FS Fiberfill	1	1	2
Mesh SM 135	1	1	2
Spacer	1	2	3

From the TAC calculation, it was found that the most optimal solution was found in the Q \* Li method of Rp. 135,982,935 while for WW method Rp. 137,453,491 and Q \* method of Rp. 187,339,290.

## CONCLUSIONS

The conclusion that can be drawn from the results of the calculation is that Q \* validation is in the capacity of the purchase quantity > 500 so Q \* at that interval is used to calculate the value of the investment. The investment value Q \* is greater than the initial investment value (Rp. 196. 334,184 > Rp. 104,389,193) with the necessary Q \* Li calculation to achieve satisfactory results. With the calculation of Q \* Li proves that the investment value Q \* Li is equal to the initial investment value of Rp. 104,389,193, then calculating TAC from Q \*, Q \* Li and WW methods. WW TAC value is Rp.

137,453,491, Q method is Rp. 187,339,290 and Q \* Li method of Rp. 135,982,935. Thus it can be concluded that the most optimal solution and can be used as a recommendation for planning multi-item inventory in the garment world Intimates Apparel is to use the Q \* Li method. The method is more optimal because the number of economic orders is smaller than other methods with a smaller ordering frequency.

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